WHAT IS CLAIMED IS:

1. An image processing apparatus comprising:

image input means for inputting an image;

extraction means for extracting an outline of the image that has been input by said image input means;

vector generating means for generating vector information conforming to state of pixels neighboring each pixel constituting the output that has been extracted by said extraction means; and

embedding means for altering the image in accordance with watermark information and embedding the watermark information on the basis of the vector information.

2. The apparatus according to claim 1, wherein the vector information is 8-dimension vector information indicating whether there are eight pixels neighboring a pixel of interest.

3. An image processing method comprising:

an image input step of inputting an image;

an extraction step of extracting an outline of the image that has been input at said image input step;

a vector generating step of generating vector information conforming to state of pixels neighboring each pixel constituting the output that has been

extracted at said extraction step; and

an embedding step of altering the image in accordance with watermark information and embedding the watermark information on the basis of the vector information.

4. The method according to claim 3, wherein the vector information is 8-dimension vector information indicating whether there are eight pixels neighboring a pixel of interest.

5. An image processing apparatus for processing a binary image input thereto, comprising:

arithmetic means for obtaining an average of pattern scores of a target binary image based upon the target binary image and first principal component values of a reference pattern;

comparison means for comparing the average of pattern scores of the target binary image and a reference-pattern score that is based upon a sum total of distances between a first principal component direction of the reference pattern and a standard vector;

translation means for translating feature vector space of the target binary image in accordance with result of the comparison by said comparison means and

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a module for an altering step of altering the target binary image based upon a result obtained by translating the feature vector space.

62. A computer-readable storage medium storing a program for executing an image processing method for processing an input image, said storage medium comprising:

a module for an extraction step of reading a document image and extracting an outline of the image;

a module for a first distance calculation step of obtaining a first Mahalanobis distance between feature space of an image, which corresponds to the outline, and a standard vector;

a module for a second distance calculation step of obtaining a second Mahalanobis distance between a reference-pattern feature space and the standard vector;

a module for a difference calculation step of obtaining the difference between the first and second Mahalanobis distances; and

a module for a detection step of detecting control information, which has been embedded in the document image, in accordance with the difference obtained by the module for said difference calculation step.

~~63.~~ 5 A computer-readable storage medium storing a

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program for executing an image processing method for processing an input image, said storage medium comprising:

a module for an image input step of inputting an image;

a module for an extraction step of extracting an outline of the image that has been input by the module for said image input step;

a module for a vector generating step of generating vector information conforming to state of pixels neighboring each pixel constituting the output that has been extracted by the module for said extraction step; and

a module for an embedding step of altering the image in accordance with watermark information and embedding the watermark information on the basis of the vector information.

access control information to be embedded in the target binary image; and

altering means for altering the target binary image based upon a result obtained by translating the feature vector space.

6. The apparatus according to claim 5, wherein the average of pattern scores of the target binary image is obtained based upon the following equation:

$$zz1^* = (a11\mu1^* + a12\mu2^* + a13\mu3^* + a14\mu4^* + a15\mu5^* + a16\mu6^* + a17\mu7^* + a18\mu8^*)/p;$$

where a11, ···, a18 represent first principle components of the reference pattern, μ1*, ···, μ8* represent component values of pattern feature space of a standardized binary image, and p represents a number of pixels in the pattern feature space of the binary image.

7. The apparatus according to claim 5, wherein said translation means translates the feature vector space in a direction in which there is an increase in the value of each element of the feature vector of the target binary image.

8. The apparatus according to claim 5, wherein the reference-pattern score is obtained based upon the following equation:

z1* = a11x1* + a12x2* + a13x3* + a14x4* + a15x5* + a16x6* + a17x7* + a18x8*;

where a11, ···, a18 represent first principle components of the reference pattern and x1*, ···, x8* represent component values of a standardized standard vector.

9. The apparatus according to claim 5, wherein the pattern feature space is a set of vector information indicating whether each pixel in an outline image of the target binary image has a neighboring pixel.

10. The apparatus according to claim 5, wherein said translation means translates the feature vector space in such a manner that the average of pattern scores of the target binary image will exceed the reference-pattern score by a predetermined amount when a logic value of the access control information is "0", and translates the feature vector space in such a manner that the sum of the reference-pattern score and the predetermined amount will exceed the average of pattern scores of the target binary image when a logic value of the access control information is "1".

11. The apparatus according to claim 5, further comprising printing means for printing based upon image

data corresponding to the target binary image that has been altered by said altering means.

12. The apparatus according to claim 5, further comprising:

extraction means for reading a document image formed based upon the target binary image that has been altered by said altering means, and extracting an outline of this image;

means for obtaining an average of pattern scores of an image that corresponds to the outline;

difference calculation means for obtaining a difference between the reference-pattern score, which is based upon a sum total of distances between the first principle component direction of the reference pattern and the standard vector, and the average of pattern scores; and

detection means for detecting control information, which has been embedded in the document image, in accordance with the difference obtained by said difference calculation means.

13. An image processing apparatus comprising:

extraction means for reading a document image and extracting an outline of the image;

means for obtaining an average of pattern scores of

an image that corresponds to the outline;

difference calculation means for obtaining a difference between a reference-pattern score, which is based upon a sum total of distances between a first principal component direction of a reference pattern and the standard vector, and the average of pattern scores; and

detection means for detecting control information, which has been embedded in the document image, in accordance with the difference obtained by said difference calculation means.

14. An image processing apparatus for processing a binary image input thereto, comprising:

calculation means for calculating a pattern vector of a target binary image;

arithmetic means for calculating a correlation coefficient r between the pattern vector calculated by said calculation means and a reference-pattern vector;

input means for inputting access control information to be embedded in the target binary image;

moving means for moving feature space of the pattern vector in accordance with the access control information, which has been input by said input means, in such a manner that the correlation coefficient r that has been calculated by said arithmetic means will fall

within a predetermined range; and

altering means for altering the target binary image based upon a result obtained by moving the vector space of the feature quantity.

15. The apparatus according to claim 14, wherein said calculation means includes:

outline extraction means for extracting an outline of the target binary image; and

dividing means for dividing the outline, which has been extracted by said outline extraction means, into a plurality of blocks;

said calculation means calculating a pattern vector of each of the plurality of blocks.

16. The apparatus according to claim 15, wherein said moving means assigns each bit of the access control information, which has been input by said input means, to each block obtained by division by said dividing means, and moves the feature vector space in such a manner that the correlation coefficient r will satisfy the relation $-def < r < def$ when the particular bit is "0" and in such a manner that the correlation coefficient r will satisfy the relation $-1 \leq r < -def$ or $def \leq r \leq 1$ when the particular bit is "1".

17. The apparatus according to claim 14, wherein said moving means moves the feature vector space in a direction in which there is an increase in the value of each element of the feature vector of the target binary image.

18. The apparatus according to claim 14, wherein the feature space is a set of vector information indicating whether each pixel in an outline image of the target binary image has a neighboring pixel.

19. The apparatus according to claim 14, further comprising printing means for printing based upon image data corresponding to the target binary image that has been altered by said altering means.

20. The apparatus according to claim 14, further comprising:

extraction means for reading a document image formed based upon the target binary image that has been altered by said altering means, and extracting an outline of this image;

means for obtaining a pattern vector of an image that corresponds to the outline; and

detection means for detecting the access control information, which has been embedded in the document

image, in accordance with the correlation coefficient r, which has been calculated by said arithmetic means, between the pattern vector and the reference-pattern vector.

21. An image processing apparatus comprising:

extraction means for reading a document image and extracting an outline of the image;

means for obtaining a pattern vector of an image that corresponds to the outline;

correlation-coefficient arithmetic means for obtaining a correlation coefficient between a pattern vector of a reference pattern and the pattern vector of the image; and

detection means for detecting control information, which has been embedded in the document image, in accordance with the correlation coefficient obtained by said correlation-coefficient arithmetic means.

22. An image processing apparatus for processing a binary image input thereto, comprising:

arithmetic means for obtaining a first Mahalanobis distance between feature space of a target binary image and a standard vector;

comparison means for comparing the Mahalanobis distance of the target binary image and a second

Mahalanobis distance between feature space of a reference pattern and the standard vector;

translation means for translating a feature vector space of the target binary image in accordance with result of the comparison by said comparison means and access control information to be embedded in the target binary image; and

altering means for altering the target binary image based upon a result obtained by translating the feature vector space.

23. The apparatus according to claim 22, wherein the first Mahalanobis distance between the target binary image and standard vector is obtained based upon the following equation:

$$D2 = (x-\mu)' \sum^{-1} (x-\mu)$$

where x represents the standard vector, μ denotes an average vector of the reference-pattern feature space, $\sum^{-1}$ denotes an inverse matrix of a covariance matrix of the reference-pattern feature space and D2 denotes the Mahalanobis distance between the standard vector x and the average vector μ of the reference-pattern feature space.

24. The apparatus according to claim 22, wherein said translation means translates the feature vector space in

a direction in which there is an increase in the value of each element of the feature vector of the target binary image.

25. The apparatus according to claim 22, wherein the second Mahalanobis distance between the reference-pattern feature space and the standard vector is obtained based upon the following equation:

$$D2 = (x-\mu)'' \sum^{-1}(x-\mu)$$

where x represents the standard vector, μ denotes an average vector of an observation-pattern feature space, $\sum^{-1}$ denotes an inverse matrix of a covariance matrix of the observation-pattern feature space and D2 denotes the Mahalanobis distance between the standard vector x and the average vector μ of the observation-pattern feature space.

26. The apparatus according to claim 22, wherein the pattern feature space is a set of vector information indicating whether each pixel in an outline image of the target binary image has a neighboring pixel.

27. The apparatus according to claim 22, wherein said translation means translates the feature vector space in such a manner that the first Mahalanobis distance will exceed the second Mahalanobis distance by a

predetermined amount when a logic value of the access control information is "0", and translates the feature vector space in such a manner that the first Mahalanobis distance will be less than the sum of the second Mahalanobis distance and the predetermined amount when a logic value of the access control information is "1".

28. The apparatus according to claim 22, further comprising printing means for printing based upon image data corresponding to the target binary image that has been altered by said altering means.

29. The apparatus according to claim 22, further comprising:

extraction means for reading a document image formed based upon the target binary image that has been altered by said altering means, and extracting an outline of this image;

distance calculation means for obtaining the Mahalanobis distance between pattern feature space of the image that corresponds to the outline, and the standard vector; and

detection means for detecting the access control information, which has been embedded in the document image, in accordance with the Mahalanobis distance, which has been obtained by said distance calculation

means, and the first Mahalanobis distance.

30. An image processing apparatus comprising:

extraction means for reading a document image and extracting an outline of the image;

first distance calculation means for obtaining a first Mahalanobis distance between feature space of an image, which corresponds to the outline, and a standard vector;

second distance calculation means for obtaining a second Mahalanobis distance between a reference-pattern feature space and the standard vector;

difference calculation means for obtaining the difference between the first and second Mahalanobis distances; and

detection means for detecting control information, which has been embedded in the document image, in accordance with the difference obtained by said difference calculation means.

31. An image processing method for processing an input binary image, comprising:

an arithmetic step of obtaining an average of pattern scores of a target binary image based upon the target binary image and first principal component values of a reference pattern;

a comparison step of comparing the average of pattern scores of the target binary image and a reference-pattern score that is based upon a sum total of distances between a first principal component direction of the reference pattern and a standard vector;

a translation step of translating feature vector space of the target binary image in accordance with result of the comparison at said comparison step and access control information to be embedded in the target binary image; and

an altering step of altering the target binary image based upon a result obtained by translating the feature vector space.

32. The method according to claim 31, wherein the average of pattern scores of the target binary image is obtained based upon the following equation:

$$zz1^* = (a11\mu1^* + a12\mu2^* + a13\mu3^* + a14\mu4^* + a15\mu5^* + a16\mu6^* + a17\mu7^* + a18\mu8^*)/p;$$

where a11, ···, a18 represent first principle components of the reference pattern, μ1*, ···, μ8* represent component values of pattern feature space of a standardized binary image, and p represents a number of pixels in the pattern feature space of the binary image.

33. The method according to claim 31, wherein said translation step translates the feature vector space in a direction in which there is an increase in the value of each element of the feature vector of the target binary image.

34. The method according to claim 31, wherein the reference-pattern score is obtained based upon the following equation:

$$z1^* = a11x1^* + a12x2^* + a13x3^* + a14x4^* + a15x5^* + a16x6^* + a17x7^* + a18x8^*;$$

where a11, ···, a18 represent first principle components of the reference pattern and x1*, ···, x8* represent component values of a standardized standard vector.

35. The method according to claim 31, wherein the pattern feature space is a set of vector information indicating whether each pixel in an outline image of the target binary image has a neighboring pixel.

36. The method according to claim 31, wherein said translation step translates the feature vector space in such a manner that the average of pattern scores of the target binary image will exceed the reference-pattern score by a predetermined amount when a logic value of

the access control information is "0", and translates the feature vector space in such a manner that the sum of the reference-pattern score and the predetermined amount will exceed the average of pattern scores of the target binary image when a logic value of the access control information is "1".

37. The method according to claim 5, further comprising printing means for printing based upon image data corresponding to the target binary image that has been altered by said altering means.

38. The method according to claim 31, further comprising:

an extraction step of reading a document image formed based upon the target binary image that has been altered at said altering step, and extracting an outline of this image;

a step of obtaining an average of pattern scores of an image that corresponds to the outline;

a difference calculation step of obtaining a difference between the reference-pattern score, which is based upon a sum total of distances between the first principle component direction of the reference pattern and the standard vector, and the average of pattern scores; and

a detection step of detecting control information, which has been embedded in the document image, in accordance with the difference obtained by said difference calculation step.

39. An image processing method comprising:

an extraction step of reading a document image and extracting an outline of the image;

a step of obtaining an average of pattern scores of an image that corresponds to the outline;

a difference calculation step of obtaining a difference between a reference-pattern score, which is based upon a sum total of distances between a first principal component direction of a reference pattern and the standard vector, and the average of pattern scores; and

a detection step of detecting control information, which has been embedded in the document image, in accordance with the difference obtained at said difference calculation step.

40. An image processing method for processing an input binary image, comprising:

a calculation step of calculating a pattern vector of a target binary image;

an arithmetic step of calculating a correlation

coefficient r between the pattern vector calculated at said calculation step and a reference-pattern vector;

an input step of inputting access control information to be embedded in the target binary image;

a moving step of moving feature space of the pattern vector in accordance with the access control information, which has been input at said input step, in such a manner that the correlation coefficient r that has been calculated at said arithmetic step will fall within a predetermined range; and

an altering step of altering the target binary image based upon a result obtained by moving the vector space of the feature quantity.

41. The method according to claim 40, wherein said calculation step includes:

an outline extraction step of extracting an outline of the target binary image; and

a dividing step of dividing the outline, which has been extracted at said outline extraction step, into a plurality of blocks;

said calculation step calculating a pattern vector of each of the plurality of blocks.

42. The method according to claim 40, wherein said moving step assigns each bit of the access control

information, which has been input at said input step, to each block obtained by division at said dividing step, and moves the feature vector space in such a manner that the correlation coefficient r will satisfy the relation $-def < r < def$ when the particular bit is "0" and in such a manner that the correlation coefficient r will satisfy the relation $-1 \leq r < -def$ or $def \leq r \leq 1$ when the particular bit is "1".

43. The method according to claim 40, wherein said moving step moves the feature vector space in a direction in which there is an increase in the value of each element of the feature vector of the target binary image.

44. The method according to claim 40, wherein the feature space is a set of vector information indicating whether each pixel in an outline image of the target binary image has a neighboring pixel.

45. The method according to claim 40, further comprising a printing step of printing based upon image data corresponding to the target binary image that has been altered at said altering step.

46. The method according to claim 40, further

comprising:

an extraction step of reading a document image formed based upon the target binary image that has been altered at said altering step, and extracting an outline of this image;

a step of obtaining a pattern vector of an image that corresponds to the outline; and

a detection step of detecting the access control information, which has been embedded in the document image, in accordance with the correlation coefficient r, which has been calculated at said arithmetic step, between the pattern vector and the reference-pattern vector.

47. An image processing method comprising:

an extraction step of reading a document image and extracting an outline of the image;

a step of obtaining a pattern vector of an image that corresponds to the outline;

a correlation-coefficient arithmetic step of obtaining a correlation coefficient between a pattern vector of a reference pattern and the pattern vector of the image; and

a detection step of detecting control information, which has been embedded in the document image, in accordance with the correlation coefficient obtained at

said correlation-coefficient arithmetic step.

48. An image processing method for processing an input binary image, comprising:

an arithmetic step of obtaining a first Mahalanobis distance between feature space of a target binary image and a standard vector;

a comparison step of comparing the Mahalanobis distance of the target binary image and a second Mahalanobis distance between feature space of a reference pattern and the standard vector;

a translation step of translating a feature vector space of the target binary image in accordance with result of the comparison at said comparison step and access control information to be embedded in the target binary image; and

an altering step of altering the target binary image based upon a result obtained by translating the feature vector space.

49. The method according to claim 48, wherein the first Mahalanobis distance between the target binary image and standard vector is obtained based upon the following equation:

$$D2 = (x-\mu)' \sum^{-1} (x-\mu)$$

where x represents the standard vector, μ denotes

an average vector of the reference-pattern feature space, $\sum^{-1}$ denotes an inverse matrix of a covariance matrix of the reference-pattern feature space and D2 denotes the Mahalanobis distance between the standard vector x and the average vector μ of the reference-pattern feature space.

50. The method according to claim 48, wherein said translation step translates the feature vector space in a direction in which there is an increase in the value of each element of the feature vector of the target binary image.

51. The method according to claim 48, wherein the second Mahalanobis distance between the reference-pattern feature space and the standard vector is obtained based upon the following equation:

$$D2 = (x-\mu)" \sum^{-1}(x-\mu)$$

where x represents the standard vector, μ denotes an average vector of an observation-pattern feature space, $\sum^{-1}$ denotes an inverse matrix of a covariance matrix of the observation-pattern feature space and D2 denotes the Mahalanobis distance between the standard vector x and the average vector μ of the observation-pattern feature space.

52. The method according to claim 48, wherein the pattern feature space is a set of vector information indicating whether each pixel in an outline image of the target binary image has a neighboring pixel.

53. The method according to claim 48, wherein said translation step translates the feature vector space in such a manner that the first Mahalanobis distance will exceed the second Mahalanobis distance by a predetermined amount when a logic value of the access control information is "0", and translates the feature vector space in such a manner that the first Mahalanobis distance will be less than the sum of the second Mahalanobis distance and the predetermined amount when a logic value of the access control information is "1".

54. The method according to claim 48, further comprising a printing step of printing based upon image data corresponding to the target binary image that has been altered at said altering step.

55. The method according to claim 48, further comprising:

an extraction step of reading a document image formed based upon the target binary image that has been altered at said altering step, and extracting an outline

of this image;

a distance calculation step of obtaining the Mahalanobis distance between pattern feature space of the image that corresponds to the outline, and the standard vector; and

a detection step of detecting the access control information, which has been embedded in the document image, in accordance with the Mahalanobis distance, which has been obtained at said distance calculation step, and the first Mahalanobis distance.

56. An image processing method comprising:

an extraction step of reading a document image and extracting an outline of the image;

a first distance calculation step of obtaining a first Mahalanobis distance between feature space of an image, which corresponds to the outline, and a standard vector;

a second distance calculation step of obtaining a second Mahalanobis distance between a reference-pattern feature space and the standard vector;

a difference calculation step of obtaining the difference between the first and second Mahalanobis distances; and

a detection step of detecting control information, which has been embedded in the document image, in

accordance with the difference obtained at said difference calculation step.

57. A computer-readable storage medium storing a program for executing an image processing method for processing an input binary image, said storage medium comprising:

a module for an arithmetic step of obtaining an average of pattern scores of a target binary image based upon the target binary image and first principal component values of a reference pattern;

a module for a comparison step of comparing the average of pattern scores of the target binary image and a reference-pattern score that is based upon a sum total of distances between a first principal component direction of the reference pattern and a standard vector;

a module for a translation step of translating feature vector space of the target binary image in accordance with result of the comparison by the module for said comparison step and access control information to be embedded in the target binary image; and

a module for an altering step of altering the target binary image based upon a result obtained by translating the feature vector space.

58. A computer-readable storage medium storing a program for executing an image processing method for processing an input image, said storage medium comprising:

a module for an extraction step of reading a document image and extracting an outline of the image;

a module for a step of obtaining an average of pattern scores of an image that corresponds to the outline;

a module for a difference calculation step of obtaining a difference between a reference-pattern score, which is based upon a sum total of distances between a first principal component direction of a reference pattern and the standard vector, and the average of pattern scores; and

a module for a detection step of detecting control information, which has been embedded in the document image, in accordance with the difference obtained by the module for said difference calculation step.

59. A computer-readable storage medium storing a program for executing an image processing method for processing an input binary image, said storage medium comprising:

a module for a calculation step of calculating a pattern vector of a target binary image;

a module for an arithmetic step of calculating a correlation coefficient between the pattern vector calculated at said calculation step and a reference-pattern vector;

a module for an input step of inputting access control information to be embedded in the target binary image;

a module for a moving step of moving feature space of the pattern vector in accordance with the access control information, which has been input by the module for said input step, in such a manner that the correlation coefficient that has been calculated by the module for said arithmetic step will fall within a predetermined range; and

a module for an altering step of altering the target binary image based upon a result obtained by moving the vector space of the feature quantity.

60. A computer-readable storage medium storing a program for executing an image processing method for processing an input image, said storage medium comprising:

a module for an extraction step of reading a document image and extracting an outline of the image;

a module for a step of obtaining a pattern vector of an image that corresponds to the outline;

a module for a correlation-coefficient arithmetic step of obtaining a correlation coefficient between a pattern vector of a reference pattern and the pattern vector of the image; and

a module for a detection step of detecting control information, which has been embedded in the document image, in accordance with the correlation coefficient obtained by the module for said correlation-coefficient arithmetic step.

61. A computer-readable storage medium storing a program for executing an image processing method for processing an input binary image, said storage medium comprising:

a module for an arithmetic step of obtaining a first Mahalanobis distance between feature space of a target binary image and a standard vector;

a module for a comparison step of comparing the Mahalanobis distance of the target binary image and a second Mahalanobis distance between feature space of a reference pattern and the standard vector;

a module for a translation step of translating a feature vector space of the target binary image in accordance with result of the comparison by the module for said comparison step and access control information to be embedded in the target binary image; and